

SECTION 290 - LIME STABILISATION OF EARTHWORKS MATERIALS

##This section cross-references Sections 173, 175 and 307.

If any of the above sections are relevant, they should be included in the specification.

If any of the above sections are not included in the specification, all references to those sections should be struck out, ensuring that the remaining text is still coherent:

290.01 DESCRIPTION

This section covers the requirements for lime stabilisation of earthworks materials within the formation. The requirements relate to preparation of the formation to be stabilised, quality of lime, spreading, mixing, and compaction of the stabilised earthworks material.

This section is not applicable for lime pre-treatment of pavement layers. For lime pre-treatment of pavement layers, Standard Section 307 – Insitu Stabilisation of Pavements with Cementitious Binders shall be used.

290.02 DEFINITIONS

Available Lime

The amount of Calcium Oxide (CaO) or Calcium Hydroxide (Ca(OH)₂) contained in Quicklime or Hydrated Lime respectively.

Available Lime Index (ALI)

The Calcium Oxide or Calcium Hydroxide content of quicklime or hydrated lime respectively, expressed as a percentage of the total mass of lime determined in accordance with AS 4489.6.1.

Design Distribution Rate of Available Lime

The spread rate of pure Calcium Oxide or Calcium Hydroxide.

Fly Ash

A fine powder of pozzolanic material extracted from the flue emissions produced from the burning of black coal.

Lime

Lime is either Hydrated Lime (Calcium Hydroxide) or Quicklime (Calcium Oxide).

Hydrated Lime

Hydrated lime is a powdered form of lime consisting primarily of calcium hydroxide, also referred to as slaked lime.

Lime Spreading Rate

The required spread rate of lime determined from the Design Distribution Rate of Available Lime corrected for the ALI of the lime to be used.

Quicklime

Quicklime is a fine granulated powder consisting primarily of Calcium Oxide that can be readily slaked by the application of water after it has been evenly spread to form Calcium Hydroxide.

Slag (Ground Granulated Blast Furnace Slag)

Ground Granulated Blast Furnace Slag (GGBFS) is a pozzolan produced by fine grinding of slag produced as a by-product from the smelting of iron ore.

290.03 CONFORMITY WITH DRAWINGS

Lime stabilised layers shall be finished to conform within the following limits to the levels, lines, grades, thicknesses and cross sections specified or shown on the drawings:

(a) Surface Level

Surface level measurement shall be undertaken in lots not exceeding 4000 m² in accordance with the procedures specified in Section 173 - Examination and Testing of Materials and Work (Roadworks).

Unless otherwise specified in other Standard Sections or elsewhere, the surface level of the lime stabilised layer at subgrade level at any point shall not differ by more than 15 mm above or 25 mm below the specified level.

(b) Depth of Stabilisation

The depth of lime stabilised material as specified in Clause 290.15(a) or (b) shall not at any point be less than the depth as specified in Clause 290.15 by more than 15 mm and the average depth of the lot shall be not be less than the specified depth.

(c) Alignment

Lime stabilised earthworks carried out in a boxed formation shall extend to the full width of the boxing. Where there is no boxed formation, the edges of the lime stabilised material shall not be more than 50 mm inside the specified offset from centreline or design line.

(d) Width

The width of the lime stabilised material shall not be less than that specified width by more than 50 mm.

(e) Shape

Where the finished surface of the lime stabilised material is at subgrade level, no point on the surface of the lime stabilised material shall lie more than 15 mm below a 3 m straightedge placed in any direction on the surface except on the part of the cross-section designed with a crown.

290.04 MATERIALS

Materials supplied under the Contract shall comply with the following properties:

(a) Lime

Quicklime and hydrated lime shall meet the requirements of AS1672 as listed in Section 175.

All quicklime and hydrated lime supplied to the job shall be provided with delivery docket showing an assigned ALI at the start of each production week. The assigned ALI shall be determined by averaging the six most recent test results for ALI. A test certificate for determination of the ALI shall be made available on request

Lime shall be stored in a moisture free environment and shall be re-tested for compliance with AS 1672.1 *Limes and limestones Part 1 Limes for building* if stored for more than 14 days after receipt from the manufacturer.

(b) Cementitious Binders

(i) Slag/Lime Blends

Slag and hydrated lime may be used in blended combination as a stabilising additive. The requirements for hydrated lime shall be as specified in Clause 290.04(a) above. Slag used shall be Ground Granulated Blast Furnace Slag (GGBFS) meeting the requirements of AS 3582, Supplementary cementitious materials for use with Portland and blended cement Part 2, Slag-Ground granulated iron blast furnace as listed in Section 175. The Contractor shall nominate the type, brand and source of the GGBFS to be used.

Slag/lime shall be blended uniformly in the ratio of 85% slag to 15% hydrated lime unless laboratory testing indicates that superior strength of the stabilised mixture is achieved by using a different ratio. If the blend is to be varied, the proportion of lime shall not be less than 10%. The Contractor shall provide evidence that the blend ratio has been met for all material supplied to the job. Slag/lime blend shall have a mortar bar 7 day compressive strength of 10 MPa and 28 day compressive strength of 16 MPa. The test shall be the same test specified in AS 5101.4 Method 4 Unconfined compressive strength of compacted materials for Portland and blended cements listed in Section 175, except that the cement to water ratio shall be adjusted to match the consistency of mortar produced for the compressive strength test for GB cement in accordance with the relevant Australian Standard.

(ii) Slow Cementitious Blends Incorporating Alkali Activated Slag or Fly Ash

Special blends of slow setting cementitious stabilising agents incorporating alkali activated slag or fly ash which are not produced to meet the requirements of a GB cement may be used subject to the blend satisfying the mortar bar test requirement specified in Clause 290.04(b)(i) above and the specified mix requirements. The maximum binder working time shall be determined in accordance with the VicRoads Test Method RC 330.02 Determination of the Maximum Allowable Working Time for a Cementitious Binder as listed in Section 175, to confirm that the binder is a slow setting binder.

Fly ash shall be supplied to meet the requirements of AS 3582 Supplementary cementitious materials for use with Portland and blended cement Part 1 Fly ash as listed in Section 175.

(c) Water

Water added to the material shall be clear and substantially free from sediments and detrimental impurities such as oils, salts, acids, alkalis and vegetable substances. Water supplied from sources where dissolved salts are known or likely to be present shall be tested for electrical conductivity prior to use. The electrical conductivity shall not be more than 3500 $\mu\text{S}/\text{cm}$ and the amount of chloride and sulphate in any water used shall each be no greater than 300 ppm.

Water sources classified by the relevant Water Authority as potable water shall be exempt from this requirement.

290.05 INVESTIGATION AND DETERMINATION OF DESIGN LIME SPREADING RATE

Where the Design Distribution Rate of Available Lime is not specified in Clause 290.15(b), the Contractor is required to carry out the site investigation and perform laboratory testing to determine the Design Distribution Rate of Available Lime in accordance with VicRoads Code of Practice RC 500.23 *Code of Practice for Lime Stabilised Earthworks Materials-Available lime content, assignment of CBR and % swell*. The Design Distribution Rate so determined shall satisfy all the requirements for the stabilised material as specified in Clause 290.15(a).

290.06 COMMENCEMENT OF WORK

HP *The Contractor shall not commence work until the Lime Spreading Rates have been presented to the Superintendent for review. If the Contractor is required to determine the Design Distribution Rate of Available Lime, evidence shall be produced to show that the material properties specified in Clause 290.15(a) have been met.*

290.07 CONSTRUCTION PLANT

The Contractor shall provide construction plant meeting the following requirements and capability.

(a) Lime Spreader

A purpose built mechanical spreader capable of accurately regulating the discharge of lime directly to the roadbed shall be used such that the Design Distribution Rate of Available Lime is uniformly met in accordance with the requirements of Clause 290.12.

(b) Mixing Machine

A purpose built machine mixing machine designed for insitu stabilisation of roadworks shall be used to pulverise and uniformly mix the earthworks formation material with water and lime for the specified depth of stabilisation. Rotary hoes and other types of agricultural machinery shall not be used.

After pulverisation and mixing, all stabilised material other than isolated hard rock particles up to a nominal size of 75 mm shall be capable of passing a 37.5 mm sieve.

(c) Watering Plant

Watering plant or any purpose designed watering system incorporated within the mixing machine shall be capable of uniformly distributing sufficient water to hydrate quicklime and if required add more water to increase the moisture content to aid compaction.

(d) Compaction Plant

Compaction plant shall be of such mass as to be capable of compacting the stabilised layer to the minimum density ratio throughout the depth of the layer.

290.08 CONSTRUCTION

(a) General

Construction includes the preparation of the earthworks formation, spreading of lime, slaking of quicklime, mixing, compaction, trimming and curing of the stabilised material.

(b) Pre-treatment of Earthworks

The material to be stabilised shall be pre-treated by scarifying or pulverising to the specified depth to provide an even surface capable of being trimmed to meet the requirements of Clause 290.03. Any hard rock particles larger than 75 mm shall be removed from the scarified soil.

(c) Spreading of Lime

Spreading of lime shall not be carried out at times when lime could become airborne or dispersed in such a way as to become a nuisance or a hazard to persons, property or livestock.

Lime shall be spread uniformly over the prepared surface at the Lime Spreading Rate calculated using the appropriate formula (i) or (ii) below.

- (i) Where hydrated lime has been used in the laboratory testing to determine the Design Distribution Rate of Available Lime and it is proposed to use quicklime at the job site, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = 0.76 \times \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

- (ii) Where the same type of lime (hydrated lime or quicklime) is to be used at the job site as has been used in the laboratory tests to determine the Design Distribution Rate of Available Lime, the Lime Spreading Rate shall be determined from:

$$\text{Lime Spreading Rate} = \frac{\text{Design Distribution Rate of Available Lime}}{\text{ALI of Lime to be Used (\%)}}$$

Under no circumstances shall the Design Content of Available Lime be less than 1.5% by mass as determined under VicRoads Code of Practice 500.23 *Code of Practice for Lime Stabilised Earthworks Materials-Available lime content, assignment of CBR and % swell*.

Immediately following completion of spreading of lime, the Contractor shall check and record the Average Lime Spreading Rate and the Uniformity of Spreading Rate in accordance with Clause 290.12.

If the required Lime Spreading Rate exceeds 15 kg/m² it shall be spread in two equal spreading runs with material from the first spread run being fully mixed into the earthworks material prior to the second spreading run being undertaken.

- (d) Slaking of Quicklime

Quicklime shall be slaked with sufficient water to allow full hydration to take place. Full hydration will be deemed to have been achieved when all quicklime that has been spread has changed from a cream coloured granulate to a fine white powder and there is a cessation of rising vapours.

- (e) Mixing

Where quicklime is used, mixing shall not commence until full hydration has been achieved.

All lime shall be mixed to the specified depth within 6 hours of spreading regardless of the number of spreading and mixing runs required. If lime stabilised material contains non-friable wet clay lumps with a nominal size in excess of 75 mm after the initial mixing run, the lime stabilised material shall be allowed to stand for up to 72 hours to allow sufficient time for clay lumps to dry out and react with the lime.

Once the lime stabilised material is friable it shall be remixed prior to compaction. Remixing shall proceed until all stabilised material other than isolated hard rock particles up to a nominal size of 75 mm, is capable of passing a 37.5 mm AS sieve and a minimum of at least 60% is capable of passing a 9.5 mm sieve when shaken without forcing material through the openings. The stabilised material shall be visually inspected for uniform mixing by excavating test holes for the full depth of the loose material at six random locations within each compaction test lot as defined in Clause 290.11(a).

The number of mixing runs undertaken after spreading of lime shall not be less than two

(f) Final Trimming

The surface may be further trimmed before or during compaction to meet the requirements of Clause 290.03(a) and (e).

(g) Compaction

Compaction shall not commence until the requirements of Clause 290.08(e) are met. Prior to compaction, additional moisture may be added if required to achieve the specified density ratio.

Compaction shall commence within 2 hours and be completed within 8 hours after completion of mixing.

290.09 PRELIMINARY TRIAL

If specified in Clause 290.15(c), the Contractor shall carry out a preliminary trial of the proposed stabilising operation.

The trial shall determine:

- (a) the effectiveness of the construction plant;
- (b) the number of passes of the stabilisation machine necessary to achieve uniform pulverisation and mixing;
- (c) the field moisture content required to achieve specified compaction requirements;
- (d) the rolling routine required to meet specified compaction requirements.

The trial section shall be located within the Works area.

The length of the trial section shall be between 100 and 200 metres over the full width of the area proposed for stabilisation.

HP Lime stabilisation shall not proceed outside the trial section until the Superintendent has reviewed all aspects of the work. The outcome of the Superintendent's review will be provided to the Contractor within three working days after completion of the trial. If the Specification requirements are not met for the trial, the Superintendent may direct that another trial be undertaken or that the work be re-stabilised and presented for re-assessment.

290.10 TEST ROLLING

All lime stabilised material shall be test rolled in accordance with Section 173 of the Specification.

If the Superintendent considers that a completed stabilised earthworks layer has been affected by rain or damaged in some way before a successive layer is placed, further test rolling shall be carried out by the Contractor on the layer immediately prior to being covered by a succeeding layer.

290.11 REQUIREMENTS FOR ACCEPTANCE OF COMPACTION

(a) General

Density testing shall be undertaken within 12 hours after completion of compaction. Remoulding of compacted specimens for determination of the laboratory reference density at each test site shall be completed within 24 hours after extraction of samples of stabilised material.

The work shall be assessed for compliance with Scale A or Scale B requirements for acceptance of compaction of the lot as specified in Clause 290.15. The calculation of the characteristic or mean density ratio shall be based on Standard compactive effort.

A lot shall consist of a single layer of like material and work compacted on the same day up to a maximum area of 4000 m².

For work to be tested for compliance with Scale A requirements, the number of randomly selected test sites per lot shall be six.

For work to be tested for compliance with Scale B requirements, the number of randomly selected test sites per lot shall be three.

If the depth of stabilisation or any compacted layer exceeds 200 mm, the Contractor shall measure and assess the field density in two sub-layers in accordance with VicRoads Code of Practice 500.05.

(b) Scale A Requirements for Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the characteristic value of density ratio of the lot is not less than 99.0%. If the characteristic density ratio is less than 99% the material shall be immediately reworked and/or re-compacted as specified in Clause 290.08(g) to meet specification requirements.

(c) Scale B Requirements for Lot Acceptance of Compaction

The work represented by the lot will be accepted as far as compaction is concerned if the mean density ratio for the lot is not less than 99.0%. If the mean density ratio is less than 99% the material shall be immediately reworked and/or re-compacted as specified in Clause 290.08(g) to meet specification requirements.

290.12 REQUIREMENTS FOR TESTING AND ACCEPTANCE OF LIME SPREADING RATE

(a) Mat or Tray System

The average Lime Spreading Rate shall be ascertained by dividing the mass of lime used by the area over which the lime has been spread. Where the average Lime Spreading Rate is less than specified, additional lime shall be spread over the surface to bring the average Lime Spreading Rate up to at least the specified rate.

The Contractor shall check the uniformity of the spreading of lime at the frequency specified in Table 290.131 by placing a minimum of three mats or trays with a plan area not less than 1 m² in the path of the spreading vehicle at an equal spacing of not less than 25% of the length of the spreading run. The Lime Spreading Rate over each mat or tray shall be calculated by dividing the mass of lime deposited on each mat or tray by the plan area of the mat or tray. Where the Lime Spreading Rate so determined for any mat or tray is less than the specified rate by more than 10%, additional lime shall be spread over the part or all of the area over which the lime has been spread.

(b) Continuous Weighing System

The mass of lime spread over the pavement surface may be measured and recorded by a spreader fitted with a fully calibrated computerised electronic weigh scale system capable of continuously measuring and recording the mass of lime at intervals of not more than 100 m of forward travel. If requested by the Superintendent, the Contractor shall produce the print out of the actual Lime Spreading Rate.

The Contractor shall have a current certificate of calibration for the computerised spreading equipment and shall produce evidence of the actual running spread rate when requested by the Superintendent.

290.13 MINIMUM TESTING FREQUENCY

(a) General

The Contractor shall carry out testing at a frequency which is sufficient to ensure that the materials and work supplied under the Contract complies with the specified requirements but which is not less than that shown in Table 290.131.

(b) Frequency of Density Testing for Assessment of Compaction

The Contractor shall initially test every lot for acceptance of compaction in accordance with the requirements of the Specification. Density testing of every lot shall continue until three consecutive lots of like material or work have achieved the specified standard when tested for the first time. The Contractor may reduce the frequency of density testing to the minimum testing requirements specified after satisfying the above requirement.

If the Contractor has satisfied the above requirement and is density testing lots at the minimum test frequency and any lot fails to achieve the specified standard, the Contractor shall test all subsequent lots until three consecutive lots of like material or work have achieved the specified standard, at which time the frequency of density testing may again be reduced to the minimum frequency.

For the purposes of this sub-clause, acceptance of compaction for small areas as defined in Section 173 will not be regarded as satisfying the initial testing requirements stated above.

Table 290.131 Frequency of Testing

Test	Minimum Frequency of Testing
Available Lime / Available Lime Index	One test per production day at the point of manufacture.
Uniformity of Spreading Rate	A mat or tray test (minimum of three mats or trays as specified in Clause 290.12(a) for each separate continuous spreading run except where calibrated load cell computerised spreading devices are fitted with a system to continuously monitor the lime spreading rate every 100 m.
Average Lime Spreading Rate	Each continuous spreader run with no breaks or pauses in spreading.
Uniformity of Mixing	For each compaction lot – Visual inspection of six random test holes excavated for the full depth of the loose material after mixing of the binder prior to commencement of compaction.
Characteristic or Mean Density Ratio	Every second lot subject to the qualifying period as defined in Clause 290.13(b).

290.14 CURING AND PROTECTION OF COMPACTED LAYERS

The surface of the compacted layer shall be kept continually moist, and free from contamination until the succeeding layer is placed.

*** If the stabilised material overlies an expansive material with a percentage swell exceeding 2.5%, the stabilised material shall be maintained at a minimum characteristic moisture ratio of ##:90%.

290.15 SCHEDULE OF DETAILS

*** (a) Job Details and Design Requirements ##(strikethrough this clause if the Design Distribution Rates of Available Lime are to be specified in Clause 290.15(b)):

Job details and design requirements are shown in Table 290.151.

Table 290.151 Job Details (Contractor Design) ##(delete all # symbols. Limit after # symbol may be changed or deleted if not required):

Road	Location		Minimum CBR Strength	Maximum Swell %	Maximum Permeability m/sec	Minimum Depth of Stabilisation (mm)	Compaction Assessment (Scale A or B)
	From	To					
##:	##:	##:	##:	##:1.5%	##:5 x 10 ⁻⁹	##:	##:

*** (b) Job Details and Design Distribution Rates ##(strikethrough this clause if the Contractor is to determine the Design Distribution Rate of Available Lime from the job details and design requirements specified in Clause 290.15(a) above):

Job details and Design Distribution Rates of Available Lime are shown in Table 290.152.

Table 290.152 Design Distribution Rates of Available Lime (Department of State Growth Design) ##(insert values as appropriate and delete all # symbols):

Road	Location		Design Distribution Rate of Available Lime * (kg/m ²)	Minimum Depth of Stabilisation (mm)	Compaction Assessment (Scale A or B)
	From	To			
##:	##:	##:	##:	##:	##:

* This figure is to be used to determine the Lime Spreading Rate in the formula given in Clause 290.08(c) once the Available Lime Index of the lime to be used on the job is known. ##(in the paragraph below, strikethrough inapplicable word(s)):

*** (c) A preliminary trial ##is/:is not required.